3.20 RESULTS FOR ANTENNA GAIN

The following assessment is based on a comparison of the antenna pattern plot derived from measured data and presented in Reference 7 and the antenna plots produced with *RADGUNS* v.1.9 and v.2.0 for the same system. The model should produce an antenna gain plot similar to the plot shown in the reference. Results for this assessment are shown in Table 3.20-1.

TABLE 3.20-1. Summary of Results for Antenna Gain FE.

	Version 1.9	**Version 2.0**
% Difference:		
3-dB beamwidth	15.3	0
Location of 1st minimum	31.9	0
Location of 1st maximum	15.4	0
Location of 2nd minimum	19.4	0
Location of 2nd maximum	10.1	0
Gain Ratio (Reference:RADGUNS)		
1st minimum	10.7:1	1:1
1st maximum	2.0:1	1:1
2nd minimum	0.9:1	1:1
2nd maximum	1.1:1	1:1

3.20.1 Assessment

Test Data Description. Antenna pattern plots are shown in Reference 7 for both azimuth and elevation cuts at three different operating frequencies. Measurements were taken at scanner positions of 0, 90, 180, and 270 deg with the system in conical scan mode. Averages of opposing scanner position pairs (0/180 and 90/270) are presented for both azimuth and elevation at the three frequencies. Averages of the four quadrature angles for both azimuth and elevation are also presented, as well as an average of the azimuth and elevation quadrature averages at each of the frequencies. An associated average is then presented which is the frequency independent average of the azimuth and elevation quadrature averages. The average of all 24 measurements (azimuth and elevation cuts at four quadrature angles and three frequencies) are presented as a composite average. A final average of the right and left half planes is presented and referred to as the rotationally-symmetric average. Comparisons of model data are made against this average.

Validation Methodology. Function ANTTRK in *RADGUNS* calculates the fraction of the maximum antenna gain as a function of the angle between the center of the antenna beam and the vector pointing toward the target, clutter patch or jammer. In v.1.9, the antenna gain function is composed of four separate functions: one for the main lobe, two for the two side lobes, and a constant function for angles beyond the second side lobe. The three lobe functions are of the $(\sin x/x)^2$ form; thus the composite pattern should produce an antenna pattern similar to the rotationally-symmetric average shown in Reference 7. To test this functionality, the model was executed using the ANTPLT simulation type. This option writes antenna gain as a function of angle off-boresight to an external file.

The composite function in v.1.9 was replaced in v.2.0 with a lookup table populated with data from the rotationally-symmetric average presented in the reference. Again, the model was executed using the ANTPLT simulation type.

3.20.2 Results

The dotted line in Figure 3.20-1 represents the antenna pattern produced by *RADGUNS* v.1.9. The rotationally-symmetrical antenna pattern from Reference 7 is shown by the solid line. *RADGUNS* v.2.0 output (shown every 0.1 deg with a dot) is superimposed on top of the Reference 7 data. A visual inspection of Version 1.9 reveals that the model does not accurately reflect the actual system in terms of half-power beamwidth or the location off-boresight and magnitude of each of the side lobes.

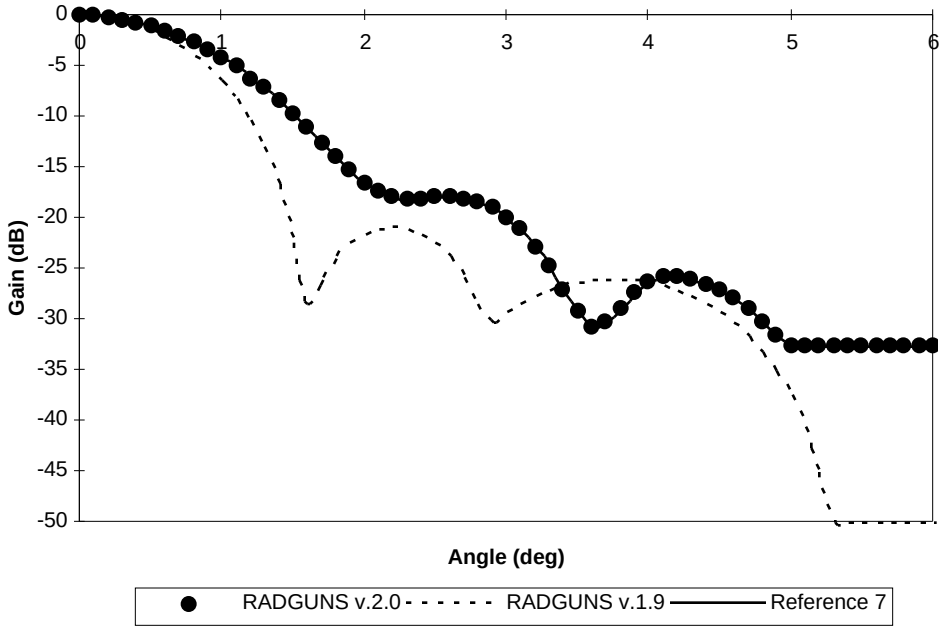

FIGURE 3.20-1. Antenna Gain Comparison.

The modeled 3-dB beamwidth is 15.3% narrower than that shown in Reference 7. Table 3.20-2 compares the location and magnitude of each of the maxima and minima.

TABLE 3.20-2. RADGUNS v.1.9 Antenna Pattern Comparison.

	Reference 7		**RADGUNS v.1.9**	
	Location (deg)	**Magnitude (dB)**	**Location (deg)**	**Magnitude (dB)**
1st Minima	2.35	-18.1	1.60	-28.4
1st Maxima	2.60	-17.9	2.20	-20.8
2nd Minima	3.60	-30.7	2.90	-30.4
2nd Maxima	4.20	-25.8	3.75	-26.0
Minimum Gain	NA	NA	beyond 5.30	-50.0

The first minima is much deeper and occurs at a much smaller angle off-boresight in the model. In terms of Watts, the measured maximum gain of the first side lobe is nearly twice the modeled gain and occurs 0.4 deg further off-boresight. The model approximates the minimum and maximum gain of the second side lobe reasonably well, however the minimum in the model is reached 0.7 deg closer to center than in the system, and the width of the second side lobe in the model is significantly larger than that of the system.

3.20.3 Conclusions

Function ANTTRK in *RADGUNS* v.1.9 does not produce an antenna pattern similar to the antenna pattern shown in Reference 7 in terms of half-power beamwidth and the position and magnitude of each of the side lobes. This is due, in part, to the $(\sin x/x)^2$ antenna pattern implemented in that model version. This representation is reasonable for the main lobe which is symmetrical about the beam center, but breaks down for the side lobes which are not symmetrical about their maximum gains. This discrepancy was reported in MDR 95-008. As a result, the model developer replaced the calculation of antenna gain as a function of angle off-boresight in *RADGUNS* v.2.0 with a table lookup. Because the table is populated with data from Reference 7, model correlation is perfect. Sensitivity analysis on this functional element has shown the model to be relatively insensitive to changes in antenna gain in terms of tracking and shooting performance on straight and level engagements at different speeds against a medium sized aircraft. Therefore, the effect of this change on overall model performance should be minor.